STAT

Sanitized Copy Approved for Release 2011/04/08 :
CIA-RDP81-00280R000200160006-3

SETS OF RELAYS FOR TWIN-CONDUCTOR CAPACITOR-TYPE CONNECTING LINKS FOR THE ATS-47

Vestnik Svyazi /Communications Herald/, No 4, 1954, Moscow, pages 3-7

L. Ya. Eydel'man, Engineer, Scientific Worker, TsNIIS

The article examines the circuits and the installation of sets of relays for twin-conductor capacitor-type connecting lines for the ATS-47; the principle of operation of these sets is based on a new Russian ring-off method. A device is described which automatically eliminates the failure to ring-off in 2-conductor connecting lines equipped with the above relay sets.

General Information

To make effective use of the capacity of existing interstation cables of municipal telephone networks and to reduce the cost of newly-installed cables, the TsNIIS /Tsentral'niy Nauchno-issledovatel'skiy Institut Svyazi — Central Scientific Research Institute for Communication/ has simultaneously developed 2 variants of relay sets for twin-conductor interstation connecting lines: the neon-lamp connecting line relay, which subsequently was modernized into a thyratron connecting-line relay (RSL-T), and a variant of a connecting line relay of the capacitor type (RSL-K). The development of connecting line relay sets with gas-filled tubes /see Note below/ has resulted principally in the possibility of insuring a rather high input resistance of the ring-off relay connected in series with the tube in the speech wires. This was the principal advantage of a connecting-line relay of this type, for its development eliminated the need of investigating the distortion of the dialing pulses when twin conductor connecting lines are used.

(/Note:/ RSL-T sets are described in Vestnik Svyazi, No 1, 1952.)

It turned out later, however, that the use of a semifinished article such as a thyratron, which is nonstandard for the ATS /avtomaticheskaya telefonnaya stantsiya — automatic telephone station/, not only fails to improve the circuit, but also leads to certain serious shortcomings. The principal shortcomings are: (1) increased value of the employed alternating current voltage (160 v); (2) need of installing a 25-cycle AC generator in the ATS and of installing step-up transformers as well as signal racks, equipped with panels containing switching and signal relays, voltmeters with signal contacts, and other instruments; (3) use of the loop method of transmitting the AC ring-off signal; this method unavoidably causes spinning of the brushes of the selectors of the various steps and an excessive wear of the mechanism whenever the subscriber fails to make connection during the time that the number is dialed, and also during the process of eliminating the failure to ring-off in the called sets of connecting line relays; (4) the need for storing at each ATS a considerable number of spare thyratrons which are relatively expensive; (5) need for providing each ATS with special instruments for testing the thyratrons.

In the development of the RSL-K sets, the principle of operation of which is based on a new Russian ring-off method /see Note below/, the aim was to use in these sets only those elements that are quite stable and that do not differ at all from those ordinarily used in the ATS circuits. Such twin-conductor connecting-line relays, being of the same type as the equipment of any ATS, could easily be produced by the

industry. It would also be desirable to avoid employing supplementary sources of alternating-current and step-up transformers.

(/Note:/ Inventor's certificate No 90,533, class 21 a^3, 34/20, priority of 6 April 1950.)

The following basic technical requirements were imposed on the developed twin-conductor connecting-line relays: (1) reliable operation over connecting lines, in which the resistance of each wire does not exceed 1,500 ohms on the section from the IGI /First Group Selector/ to the LI /Line Selector/; (2) the connecting-line relay sets must not impair the quality of the telephone communication and must not introduce changes in the circuits of the basic ATS instruments; (3) 2 sections of twin-conductor connecting lines should be capable of being connected in one speech path; (4) the use of the connecting-line relays should not cause excessive wear on the selectors owing to spinning of their brushes at the instant when a ring-off pulse passes through the connecting line.

The circuits developed for the calling and called sets RSL-K for the ATS-47 fully satisfy the above requirements. These sets insure reliable action over the connecting line, in which each wire has a resistance exceeding 2,000 ohms, using the existing station common 25-cycle source of ringing current to transmit the ring-off pulses. Prolonged experimental operation of commercial sets RSL-T and RSL-K has shown that at present the RSL-K sets are the most acceptable. The industry has already started output of new, larger experimental series of these sets.

The features of the twin-conductor RSL-K circuits, their basic shortcomings, and methods of eliminating these shortcomings will be discussed below, after we shall describe the principal RSL-K circuits which were perfected during the experimental operation.

Current Flow in the RSL-K Circuits

The RSL-K circuits are installed in regionalized municipal telephone networks, equipped with decade-stepped ATS. Each twin-conductor connecting line is connected on one end to the output of the calling set of connecting-line relays (out RSL) and the other end to the input of the called set (in RSL), as shown in Figure 1. These sets are intended for connecting the twin-conductor connection lines from the decade-stepped ATS to the decade-stepped ones (Figures 1a and b), from decade-stepped ATS to machine ones through intermediate equipment (Figure 1c), and from machine ATS to decade-stepped ones with the countering set (VK) being directly connected to the calling connecting-line relay set (Figure 1d).

The principal diagram of the RSL-K sets is shown in Figure 2. It contains 5 type-RPN relays, of which 3 belong to the calling and 2 to the called sets. The circuit is based on the principle of engaging and releasing the sets of the called station whenever short-period pulses, transmitted by the calling connecting-line relay sets are received, and provides for continuous supervision of the working order of the connecting lines, of the presence and working order of the called connecting-line relay sets and of the II/IV GI /II/IV Group Selector/ (or other sets) connected with it. For this purpose a control relay K (7,300 ohms) is provided in the calling set, and this relay operates in the loop of the connecting line, receiving the plus feed from contact 2-1 of push-button Bl. Kn. of the called connecting-line relay set over wire a, and receiving the minus feed from relay O in the II/IV GI circuit over

wire c and further through the winding of relay Z (350 ohms and 1,000 ohms) over wire b. In this circuit, the relay Z of the called connecting-line relay set and relay O in the II/IV GI circuit do not operate, for they do not receive enough current.

If the control circuit is in working order relay K pulls in its armature and contacts k^{I} (1-2) and k^{V} (1-2) prepare the circuit of the calling connecting-line relay set for engagement by the selector of the preceding selection step (over wire c) and by mixing selector SI (over wire b). In addition, contact k^{III} (2-3) of this relay opens the circuit to the signal lamp SL and contact k^{V} (3-4) of this relay disconnects the connecting-line relay set from the discard circuit.

When the brushes of the IGI (or of the II/IV GI) stop on the outlets to the free calling set, the test relay P will operate in the circuit of this group selector, receiving a minus feed over the c wire through relay O (350 ohm) of the calling set. Relay O in this circuit operates and seals in with contact o^{I} (1-2) until relay R operates. Contact o^{III} (4-5) of the O relay connects the high-speed relay R, and contacts o^{V} (2-3) and o^{I} (1-3) break the control circuit and connect wire b, while contacts o^{V} (1-2) and o^{III} (3-4) prepare the circuit that registers the load and breaks the discard circuit. Relay K releases its armature with a time delay of 50 to 60 milliseconds, owing to the transition contact o^{V} (1-3), which shunts the winding of this relay. During this time the engagement pulse will arrive from the calling-set circuit, and this pulse will actuate the engagement relay Z in the incoming set, receiving the plus feed over wire b of the connecting line from the contact k^{III} (2-3) and the minus feed over wire c from the II/IV GI circuit.

Mounted on relay Z are the transfer-switching contact groups No 95 (z^{I} and z^{V}); therefore a triple contact is formed in them prior to the opening, and relay Z received additional supply over a local circuit and is sealed-in in this circuit by contact z^{V} (1-3). Contacts Z^{I} (1-3) and Z^{III} (4-5) connect the conversation wires a and b, while contact z^{III} (1-2) closes the circuit for "added supply" of the winding of relay O, which is connected by contact z^{V} (1-3) through resistor r2.

In the outgoing set, relay R pulls in its armature after relay O operates. The contacts r^{V} (4-3) and r^{V} (4-5) of this relay remove the shunt from the second winding of relay O and connect this winding to wire c; as a result the holding circuit of relay O remains on after contact k^{I} (1-2) opens, and the set seals-in until the ring-off pulse is transmitted. Contacts r^{I} (1-2) and r^{III} (3-2) prepare the circuit by which this pulse is transmitted with alternating current and eliminate the possibility of the control circuit becoming closed after the armature of relay O drops out in the calling RSL set. Contacts r^{V} (3-4) and r^{I} (4-5) break the circuit that tests for engagement of mixing selector SI over wire d and close the circuit to counter Sch which records the number of engagements. Thus, once the called set becomes engaged, relay Z remains energized in it, while relays O and R remain energized in the calling set. Connected in parallel to the speech wires of the receiving set is a differential bridge (consisting of 2 0.5 microfarad capacitors, the 2 pairs of symmetric windings of relay Z, and choke L), and the ring-off relay O is connected to the center point of this bridge.

The process of further dialing the number and establishing the connection is carried out in the usual manner. After ring-off, the circuit over which relay O of the calling set receives its supply

from the side of the group-selector of the preceding step becomes open. Relay O releases its armature and relay R becomes deenergized. During the time that relay R drops out (80-110 milliseconds) the ring-off pulse is transmitted with alternating current over both principal circuits through the connecting line from the called station side. In the calling set, each of these circuits begins with the terminals of the secondary half-winding of the general station transformer Tr, to which is connected the 60-v central battery, and passes through a set of individual fuses for each wire, a protective lamp (L_a, L_b), a limiting resistance (r_1 and r_2) and the suitable contacts of relays O and R. In the called set these circuits comprise the contact springs of the test jack (I. Gn), the corresponding arms of the differential bridge, and the winding of ring-off relay O (2,000 ohms).

The passage of alternating current through the above-mentioned circuits causes operation of relay O, which, first of all, for a short time prior to the release of the armature of relay Z, is blocked by its contact o^{II} (1-2) in the local circuit (through resistance r_3), and whose contact o^{IV} (1-2) later breaks the holding circuit for relay Z of the called set and of relay O in the II/IV GI circuit. The latter relay releases its armature, after which the II/IV GI "goes off" into ring-off.

Releasing the armature of relay Z shunts relay O and disconnects its "added supply" and prepares for the formation of the control circuit. This method of disconnecting the ring-off relay O insures that the time needed to release its armature ranges from 350 to 380 milliseconds. Thanks to this, the called set cannot be occupied during the time that the alternating current ring-off signal passes through, even if up to 4 sections of twin-conductor connecting lines participate in the connection.

After relay R of the calling set and relay O of the receiving set release their armatures, and the brushes of the II/IV GI return to the initial position, the control circuit is again formed. Relay K of this circuit operates; the circuits of the set reach the nonworking state, and the connecting line is prepared for the next occupancy.

If the control circuit becomes damaged for some reason or other, the relay K of the calling set releases its armature, and this closes the circuit for the technical signalization. The signal relay TS (which is located on the signal panel of the RSL rack) of this circuit operates, receiving its plus supply from contact k^{III} (1-2) through the contact of relay O, pushbutton Bl. Kn., and signal lamp SL (one per panel). At the same time a circuit is produced, through which relay R receives the discard pulses over wire SU through contacts k^{V} (3-4) and o^{III} (3-4), and through the pushbutton used to disconnect the discard equipment (Kn. SU).

Within approximately one to 4 seconds a plus signal lasting for 25 to 30 seconds is transmitted from the discard equipment SU, and this results in the operation of disconnect relay R, and contacts r^{I} (1-2) and r^{III} (2-3) transmit into the connecting line an alternating-current disconnect pulse. Such pulses can arrive from the discard equipment SU every 5 seconds. If the control circuit does not become restored under the influence of the discard equipment within one minute (i.e., if the state of the so-called failure to ring-off is maintained), testifying to a damage to the connecting line or to the sets on the called ATS, the rack and row signalization will go into effect. To determine on which panel a RSL set with a faulty connecting line is located, the technician on watch should press the common pushbutton TS, which causes the signal lamp SL to glow.

Having determined the proper panel and having removed its cover, the technician can quickly find the faulty RSL set, for in this set all 3 relays are inoperative.

At the instant that the calling RSL set is blocked by the individual pushbutton Bl. Kn., the signalization circuit is broken and a repeat signalization circuit is formed by contacts 5 to 4 of this pushbutton, which circuit is closed when the control circuit is restored. In this case the technician releases pushbutton Bl. Kn., after which the signal lamps go out. If any of the rack fuses blow out in the AC circuit, the signal relay PPT on the signal panel operates and disconnects the discard equipment until a good fuse is installed.

Current Flow in Discard-Device Circuit

The discard-device circuit is shown in Figure 3. If failure to ring-off occurs, relay TS on the signal panel of the stand of the calling RSL set operates and its contact ts^{I} (1-2) prepares the circuit which connects the discard device. At the instant that a plus pulse is received from the 5-second interrupter, relays B and N (the former with a time delay not less than 70 milliseconds) operate in this circuit. Contact b^{IV} (1-2) of relay B breaks the circuit that transmits the disconnect pulses, and contact b^{IV} (2-3) connects relay A, while contact b^{II} (1-2) closes the circuit to the series-connected low-resistance windings of 6 control relays R_1-R_6. Control relays R_1-R_6 operate and seal-in with their contacts r_1^{II}(1-2), r_2^{II} (1-2), r_3^{II} (1-2), r_4^{I} (1-2), r_5^{I} (1-2), and r_6^{II} (1-2) over wires I-VI, the number of which corresponds to the number of wires of the discard device on the diagram of Figure 2.

When relay A operates, relay V becomes connected and the primary windings of control relays R_1-R_6 become disconnected. After this circuit is opened, the only control relays R_1-R_6 that keep their armatures up are those from the RSL groups, in which failure to ring-off occurred. Other control relays will release their armatures within one second, for no minus signal will be delivered to the discard device from these panels over the discard-device wires owing to the fact that the circuit is opened by the contacts of relay K or O.

When the transmission of the plus signal from the 5-second interrupter is discontinued, relay B releases its armature and contact b^{IV} (1-2) shunts the winding of relay R_1. During the time that the armature of this relay is released, relay R in the circuit that receives the discard pulses operates and its contacts r^{I} (1-2) and r^{III} (2-3) provide a circuit over which the ring-off a-c pulse is transmitted into the connecting line. At the same time relays A and V release their armatures slowly.

In the second group of RSL panels, the plus-signal will flow over wire II only after the relays R_1 and A release their armatures (after 200 milliseconds). The pulse signal will be applied in the third group of RSL panels when relay V releases its armature, when the circuit is formed by contacts b^{IV} (2-1), r_1^{IV} (2-1), r_2^{IV} (2-1), r_3^{IV} (2-3), v^{II} (4-3) and wire III. If there is failure to ring-off in the fourth group of panels, relay V again operates through contact r^{V} (1-2) and through the chain of contacts or relays R_1-R_3 after relay R_4 releases its armature, receiving the plus signal from the contact b^{IV} (1-2), and sends the IV.

If there is lack of ring-off in the fifth group, the second windings of relays A and C are connected through the contacts of relays R_1-R_5, and as a result relay A again operates; relay V, on the other hand,

releases its armatures, for its windings are connected in a differential manner. After the failure to ring-off is eliminated from the fifth group of panels and if there is failure to ring-off in the sixth group, contact r_5^V (1-2) opens the circuit to the second windings of relays A and V, and as a result a plus signal is transmitted through wire VI over a chain of contacts of relays R_1-R_6 and relay B. After relay R_6 releases its armature, the discard-device circuit returns to its initial state.

If any of the fuses in the AC circuits of the calling RSL burn out, the relay PPT on the signal panel operates. This relay, by means of contact ppt^{III} (1-2), breaks the starting circuit of the discard device until a new fuse is installed on the rack. The discard device is disconnected by means of special pushbuttons marked Kn.Su.

Construction of RSL-K Sets

The RSL sets presently contained in the ATS are mounted on 12-relay removable panels, mounted on individual racks. Each panel contains 3 sets of RSL. The capacitors are placed directly on the racks. The racks with the panels of the calling and called RSL are shown in Figures 4 and 5 respectively. The discard device is mounted on the signal panel. The frames with the signal lamps and with pushbuttons are located in the center portion of the rack. In order to reduce the cost of new commercial RSL-K sets, they will be mounted on larger removable panels (5 sets per panel). In this case a considerably smaller area will be needed to install the RSL-K, for each rack will carry 90 RSL sets instead of 50.

Results of Experimental Operation

Experimental operation of the RSL-K sets has confirmed the technical soundness and economy of application of the new ring-off method, the stable operation of the sets, and their advantages compared with other types of twin-conductor RSL. At the same time, certain shortcomings of the RSL-K sets became evident. The principal shortcomings are: (1) spinning of the selector brushes of the subsequent stages whenever ring-off occurs when the number is not reached, which causes a considerable nonproductive wear of the II/IV GI; (2) possible occurrence of so-called false engagement signals at an instance when the calling sets are engaged for a short period over wire c by the passing brushes of the selectors (the short-period engagement pulse will operate relay Z, which causes engagement of the II/IV GI, and ring-off relay O will not have time to operate, owing to the insufficient duration of the AC ring-off pulse); (3) possibility of repeated engagement of the received RSL set in the second section of the connection line, caused by the AC ring-off pulse. During control tests, the number of cases when the brushes of the selectors of the succeeding stages were spinning amounted to 24.6%, and the number of false engagements reached up to 0.06% of the total number of RSL engagements with the discard device disconnected; in addition, several cases were observed where the RSL of the second section became engaged repeatedly. These shortcomings have been eliminated in the RSL-K circuit shown in Figure 2 (see description of operation of ring-off relay O).

Basic Circuit Features of the RSL-K and of the Discard Device

A selenium rectifier is connected in the control circuit in series with relay K. The purpose of this rectifier is to prevent K relay from operating through the windings of pulse relay I in the II/IV GI or LI circuit if the relay O of the called RSL set does not operate during

[redacted] the instant of ring-off. Otherwise the subscriber, engaging such a connection, [redacted] will receive an incorrect connection. The control relay [redacted] is to signal [redacted] only faulty operation or the absence of a vacant line set and on the II/IV CI, but also to signal a break in one or 2 wires, signal the grounding of wire b, and signal a short between the wires of the connecting lines.

Among the most important features of the developed ring-off method in wide-conductor RSL are the following:

(1) The circuit employs an ordinary DC relay, so connected as to increase its sensitivity and speed of operation. It is operated by the AC ring-off pulse passing through both wires of the connecting line into the ground, without the application of rectifying elements or special slow-down devices. The "added supply" of this relay has increased significantly not only its sensitivity at any number of contact springs installed on it, but also its operating reliability, owing to the increase of the amplitude and duration of the working half-wave and reducing the amplitude and duration of the non-working AC half wave. It is evident from Figure 6 that the sinusoidal current with equal half waves (Figure 6a) which arrives from the line is converted in the presence of a "added supply" current I_{add} (Figure 6b) into an alternating current (Figure 6c) which is distinguished by a short duration of the non-working half wave and a considerable duration of the working half wave.

(2) In order to produce the ring-off, a low AC line voltage of approximately 50 to 70 v at a frequency of 25 cycle is adequate. (Because of this it may be advantageous in some cases to employ vibrator-relays as sources of alternating current for the RSL sets of a single panel.) The possibility of employing a low voltage is explained by the fact that the alternating current from the grounded source passes over both wires and the overall resistance of the differential bridge is sharply reduced by the opposing directions of the magnetic fluxes in the upper and lower windings of relay Z and of the choke. Also contributing to this circumstance is the fact that the network consisting of the ring-off relay and of the capacitors is near voltage resonance at 25 to 50 cycles under the conditions that are created in the differential-bridge circuit during the ring-off.

(3) The total impedance of the differential bridge of the called RSL set exceeds 180,000 ohms at 1,000 cycles, and therefore connecting the set hardly affects the attenuation of the talking circuit.

(4) The RSL-K sets improve the transmission of the dialing pulses, particularly if the connecting lines are of short or medium lengths (with wire resistance up to 1,000 ohms) and this increases the reliability of operation of the selector electromagnets.

(5) The dialing pulses do not affect the ring-off relay O of the called set, since the charging and discharge of current of the capacitors connected in the wires of the pulse circuit pass through the winding of this relay in opposite directions.

(6) The RSL-K sets produce ring-off with a standard source of alternating current, which does not introduce anything new in the operating conditions of the decade-stepped automatic telephone stations. Replacing the 2-winding station transformer in the signal-calling device by a 3-winding one (see diagram in Figure 2) results in matching of the polarities on the windings of the transformer and of the pulse relay of the II/IV CI; the opposing flow of the alternating current in these

windings, eliminates completely the first of the above-mentioned shortcomings, namely, the possibility of spinning the selector brushes of the next stage during ring-off if the dialing has not been completed and during the elimination of the failure to ring-off with the aid of the discarding device. During the experimental operation of the RSL-K, the station transformer for the ringing current was used as a source of alternating current. The winding of the above transformer has, as is well known, a "minus" polarity; therefore, during ring-off the pulse relay I in the II/IV GI circuit has operated sometimes because of current passing through one of the windings (with plus polarity), which receives a minus supply through the transformer winding. (It must be noted that if the loop method is used to transmit the ring-off signal with alternating current at 25 or 50 cycles it is impossible to eliminate completely cases of selector brush spinning inasmuch as the alternating current passes in series through the windings of the pulse relay I.) In order to eliminate the second of the above shortcomings, the relay O in the circuit of the calling set is blocked until relay R operates. In addition, relay R, which formerly had a time-delay winding on its core, is now equipped with a controllable time-delay winding and has thus become faster in action.

The discard device that has been developed, which is of the pulse type, and in which the plus signal is at different times to 6 groups of RSL panels, does not allow the discard pulses to enter into sets that are in working order, inasmuch as the connecting circuit of this device is formed in these sets only for the time during which the selector brushes return to the initial position, plus the duration of the time required for relay K to operate (i.e., within 300 to 400 milliseconds). However, for RSL sets that are not in working order, the relays K and O do not pull in their armatures, and therefore, prior to the arrival of the plus signal from the 5-second interrupter (i.e., for the duration of one second), the only control relays that remain blocked in the discard device are those on panels with RSL that are not in working order. The use of such a discard device insures automatic elimination of failure to ring-off prior to the appearance of a technical signal, and therefore the technical personnel is called upon to intervene only in those cases in which the connecting line or the corresponding instruments are damaged.

Economic Effect of Introducing the Twin-Conductor Connecting-Line Relays

The general shortcoming of twin-conductor connecting-line relays of any type is the need of installing supplementary equipment at the automatic telephone station and this requires a certain amount of installation space. This naturally increases somewhat the capital expenditures and the operating costs, and also the consumption of nonferrous metals for station equipment. However, technical-economic analysis has shown that these additional costs caused by the introduction of twin-conductor connecting-line relays are offset by the more considerable reduction in capacital expenditures and operating costs for line structures and by a substantial reduction in consumption of nonferrous metals in these structures. (This is based on preliminary data of the TsNIIS which can be refined only after the connecting-line relays become available in regular production.)

Therefore, the introduction of 2-conductor connecting-line relays becomes economically advantageous with respect to the various indexes under certain conditions:

(1) With respect to capital expenditures -- if the connecting line is 3.5 km long; here the consumption of nonferrous metal for station structures increases by 0.5 t, and the consumption for line structures

decreases by 10.8 t if 800 calling and called twin-conductor connecting-line relay sets are installed each in a 10,000-line automatic telephone station; at the same time the annual expenditures for maintenance of the connecting line decreases by 2.5 times.

(2) With respect to copper consumption — if the connecting line is 200 m long.

(3) With respect to operating expenses — if the connecting line is 1.3 km long.

Considering that the length of the interstation connecting lines exceeds 3.5 km in the majority of large nets and that the number of regionalized nets increased every year, it is easy to visualize the tremendous economic effect that will result from introducing twin-conductor connecting-line relays in all regionalized nets.

FIGURES

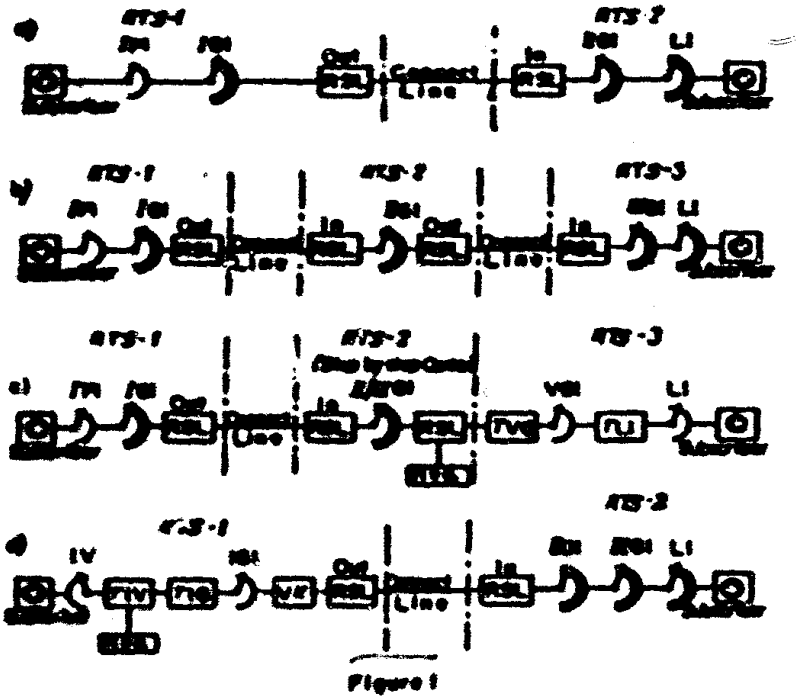

Figure 1

STAT

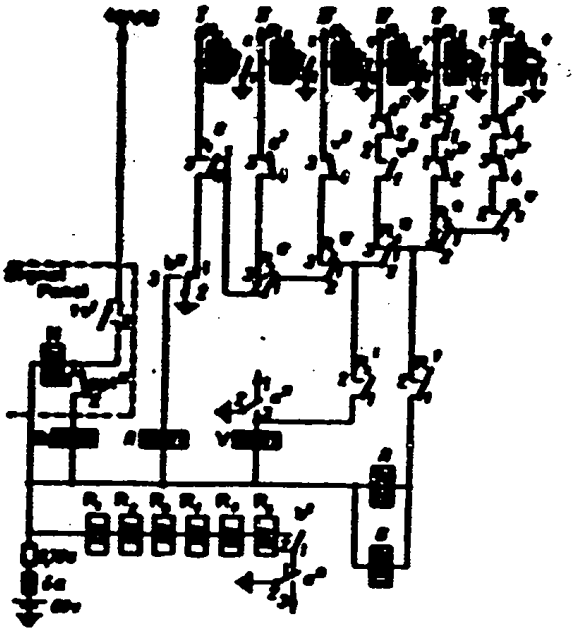

Figure 3

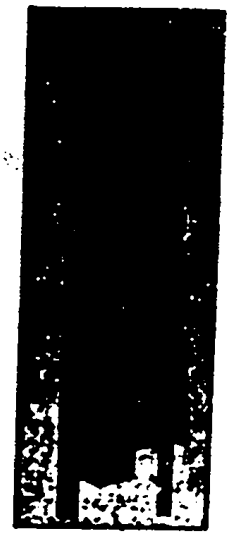

Figure 4

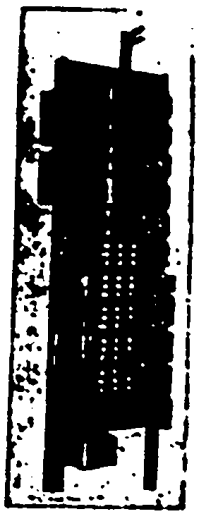

Figure 5

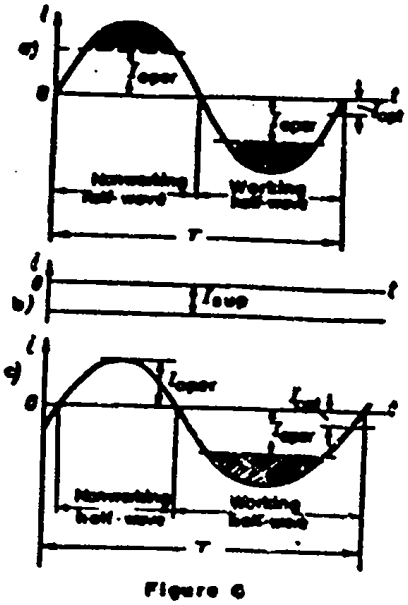

Figure 6

* * *

STAT

Sanitized Copy Approved for Release 2011/04/08 : CIA-RDP81-00280R000200160006-3